

Water, Sanitation, and the Urban Poor of India
Environmental Health Term Paper
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Global and Indian Urbanization

During the past 50 years our planet has experienced a wave of urbanization, one of the most profound demographic shifts in human history. Since 2007, for the first time ever, more of the world's population lives in urban centers than lives in rural areas. Furthermore, given the rate of population growth and continued movement, it's estimated that by 2035 over two-thirds of the world's population will live in cities.¹ This intense urbanization means that over 3.5 billion people are now living in an area covering only 1% of the earth's land surface. This historic demographic shift has had and will continue to have profound implications for global health and for the billions of people now crowded into cities, often without adequate infrastructure or access to healthcare. Often considered as an escape from the harsh realities of rural poverty, by both development advocates and the rural poor themselves, relocating to an urban environment is unfortunately not a panacea for global development. In fact, it's important to be clear that urbanization most often does not translate into development, instead leaving poor populations at equal and sometimes greater risk of acquiring various communicable and non-communicable diseases, not to mention experiencing increased human rights abuses and social injustice. Over time, with concerted development efforts, urbanization can have beneficial outcomes. The historical example of Western Europe and the United States shows us that a century of development and infrastructure investment can dramatically reduce infectious disease rates. Also, it's been noted, for example, that urban women tend to have lower fertility rates and better reproductive health outcomes than in rural areas. This does not translate to urban poor populations however, who have worse rates than other urban women and are often no better off than their rural counterparts.² Among the urban poor, the contribution of this demographic shift to changing health patterns is profound, affecting the distribution of traditional tropical diseases, such as malaria and helminth infections, and newer infectious diseases such as HIV, as well as encouraging an 'epidemiological transition' toward non-communicable diseases as urban populations assume western lifestyles.³ These poor populations live in massive urban slums, which grow along with cities and are areas of "concentrated disadvantage" often including lack of basic services, have substandard housing, and are overcrowded. In this paper I will highlight some of the health challenges posed by urbanization and slum life and some of the innovative solutions which are being used to improve the lives of the urban poor. I will focus on water and sanitation issues and will also draw a number of examples from India, including Mumbai, which has some of the largest slums in Asia and the world.

A huge percentage of modern urban growth is due to the growth of urban slums. Globally, 32% of the total urban population lives in slums. In developing countries, where the majority of urban growth is concentrated, 78% of the urban population lives in slums. In Nairobi Kenya, in 1995, for example, a city with the world's largest urban slum, Kibera, 5% of land was occupied with slums which contained over 60% of the population.² Without significant effort on this front in the last decade this problem is likely

worse today. Focusing on India we see a similar trend of urban and slum growth. India is experiencing massive urban growth, with anticipated growth from 2000 to 2015 in Calcutta, as an example, at 1.9% vs. growth in New York City of only 0.4%.⁴ Nationwide, there were only 23 cities with over 1 million people in the early 1990s. There are now over well over 35.⁵ Over 30% of the country's population now lives in urban centers and these generate over 90% of the GDP.⁶ Much of these new urban populations are also extremely poor and concentrated in slums, reflecting the global picture. In Mumbai, according to the 2001 census, 54.5% of the approximately 16 million population lives in urban slums, defined as "a compact area which had 60-70% households that were poorly built congested tenements with inadequate infrastructure (lack of proper sanitary and drinking water facilities), and located in a congested environment." Calcutta, on the eastern Indian coast, also has a high percentage of slums at 32.5% of the population. Nationally, among the million plus cities noted above, an average of 24% of the population lives in urban slums.⁷

India's slums are growing at an impressive rate due to a number of important factors. Chief among these is the massive rural to urban movement which has occurred in the last few decades. People are moving to mega-cities, such as Mumbai and Calcutta in search of economic opportunity and anticipated better lives. Dharavi, the most famous slum in Mumbai, and the claimed "largest slum in Asia" holds over 1 million people in approximately 1 square mile. Dharavi lies at the center of Mumbai and despite being present for years it continues to grow in population.⁸ This trend is not just limited to the largest cities however. Many smaller cities are also experiencing rapid growth as India continues to assert its role in the global economy. The western mid-sized city of Surat, for example, houses much of the world's diamond polishing industry and draws workers from across India. Many stay put, but many are migrants, returning to their families in rural areas only during holidays. Regardless, large numbers of people are living and working in cities like this across India. With this concentration of people also comes the growth of slums. In Surat, there are estimated to be over 300 slum pockets in which the majority of the city's poor live.⁵ The picture of urban slums in India is further complicated by the various types of housing available to the urban poor. In Mumbai specifically, there are three types of housing in which the 'poor' generally live. Chawls, which are semipermanent structures, Zopadpattis, which are squatter settlements, and 'pavement dwellings.' Not each of these is considered to officially be a slum, and therefore are considered illegal dwellings and are not eligible for many of the municipal level improvement schemes directed at slums.⁹ Misclassification may also result in an underestimate of the true burden of the slum population in Indian cities.

Health and Sanitation in Urban Slums

Urban slum life is fraught with numerous challenges and increases the risk for poor health in numerous ways. Three main categories of diseases can be identified in urban settings: diseases of poverty related to poor sanitation and lack of access to clean water as well as overcrowding; industrialization related diseases such as pollution, etc; and diseases associated with political and social instability.¹⁰ Here I will specifically focus on the diseases related to water supply and sanitation in urban slums, which fit into the category one above. These include diseases such as diarrheal diseases, geohelminths, and urban mosquito borne diseases. Also interesting to note though (but which I will not discuss below) is the increased risk of respiratory diseases due to crowding, such as TB. HIV has also increased in Indian

slums, due to high-risk sexual behaviors that often accompany urban poverty and migratory work. Numerous other diseases can also result, including injuries and non-communicable diseases related to poor diet and western lifestyles. These are all accentuated by inadequate access to health care services.

The problem of urban sanitation and water supply is particularly evident in urban slums and is due primarily to inadequate infrastructure investment and planning. Many studies and reviews note the vulnerability of slum dwellers to “inadequate access to clean water, good sanitation and waste disposal, for example, places slum dwellers at particular risk of several communicable diseases, including diarrheal diseases and helminth infections.”² A calculation of the amount of human waste produced in a typical slum quickly gives a picture of the magnitude of the problem faced in removing it. A World Health Organization study estimates that the daily fecal output of the urban populations in developing countries is greater than 500,000 tons. This translates into approximately 570 tons for a population of approximately 2.85 million based on the 1990 slum population of Lagos Nigeria.¹¹ Given this massive volume of waste, the typical urban infrastructure is not capable of safely removing it. A study examining household-level waste management and disposal practices in the Accra Metropolitan Area, Ghana showed that over 80% of households do not have access to solid waste disposal.¹² Another study from the same authors concludes that only 39.8% of households in Accra have indoor pipe and over 35.0% of households depend on unsanitary public latrines.¹³ In Mumbai, it's estimated that approximately 73% of the slums primarily use community toilets provided through the municipal authorities and approximately 25% rely primarily on open defecation. Water supply is likewise inadequate, with many slum dwellers required to carry bucket water some distance, thus both increasing their workload and also decreasing the volume available per household.⁹

Improvements in sanitation and water supply have been shown to have significant impacts on disease in both rural and urban settings and therefore, if adequate resources are committed, could be effective at reducing the burden of disease. Lewin et al. review a number of studies exploring the impact of water supply on communicable diseases. Specifically, they note a 30% reduction in the prevalence of river blindness associated with shorter distances to water supplies. Also, *Ascaris* infection prevalence was noted to be decreased by 12% in people with access to a well in their yard, and 37% in those with indoor water supply.¹⁴ A 1990 meta-analysis published in the *Bulletin of the WHO* reviewed 114 studies to “examine the impact of improved water supply and sanitation facilities on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma.” All showed significant reduction, with up to 77-78% in the case of both schistosomiasis and dracunculiasis.¹⁵ Clearly, investments in water and sanitation can have a significant impact. Such investments require ongoing municipal planning and resources however, and the likely reason for a lack of adequate investment is lack of political will. The reason for this may be in part due to some of the challenges and expense of meeting the water needs of growing urban populations. Due to an expected decentralization of future urban growth, with most population growth expected to be in medium sized cities rather than mega-cities, distributed investments in urban planning and infrastructure are needed. Municipal authorities must also protect water sources from over exploitation while balancing the needs of burgeoning populations.¹⁶ Also, as the broader development agenda progresses and household incomes increase, an accompanying increase in per household water usage is expected.¹⁶ Below I will highlight a few

efforts to clean up urban slums. First however, I will highlight a few more specifics concerning 3 types of diseases affected by water and sanitation supply in slums, diarrheal diseases, helminth infections, and insect borne diseases.

Diarrheal diseases

One of the major causes of under-5 mortality globally is a spectrum of diarrheal diseases, which often lead to dehydration and death.¹⁷ The 2002 World Health Report, from WHO, states: "About 1.7 million deaths a year worldwide are attributed to unsafe water, sanitation and hygiene, mainly through infectious diarrhoea. Nine out of ten such deaths are in children, and virtually all of the deaths are in developing countries."¹⁸ The cause of these infections is most often bacterial, resulting from the inadequate disposal of human waste. A number of recent studies highlight this problem in urban slums in particular. In Varenassi, a city on the Ganges river in India with a population of approximately 3.1 million¹⁹, a study examined the odds of diarrheal disease in the population using river water as their primary water source versus those not using the water in the year prior to the survey.²⁰ This water in particular was found to be extremely polluted, with coliform counts of up to 10^8 MPN per 100mL, due to the estimated 200 million liters of untreated human sewage discharge into the river daily, coming from over 24 individual point sources near the city. Results from this survey indicate that households using the river for bathing and drinking water, typically downstream from the pollution point sources had an OR of over 2 for developing enteric diarrheal diseases compared to those who did not use the water. A number of studies have similarly examined risk factors for development of diarrheal diseases in children in slum settings. One, from urban Kenya, showed decreased risk of diarrhea in children who consumed safe water and who lived in households with good hygiene. Also, knowledge of the biomedical cause of diarrhea and its association with unclean water by the parents resulted in decreased infections and increased use of good hygiene.²¹ A similar cohort study was conducted in south Indian slum, which indicated that infants were ill with respiratory or gastrointestinal symptoms approximately one fifth of the time during infancy, indicating a detrimental role of slum life on infant health.²²

Interventions for diarrheal diseases (and helminth infections, discussed below) are various and include: sanitation interventions, which typically provide a means of disposing excreta, water supply interventions, which can entail quantity or distribution improvements as well as water quality improvements, and hygiene interventions which entail health education and behavior change interventions, such as hand washing.¹⁷ A 2005 Lancet meta-analysis of 46 studies on sanitation, water, and hygiene interventions supports an already established body of evidence indicating that these interventions play an important role in reducing childhood diarrheal illness.¹⁷ Hand washing interventions, for example, were shown to have a relative risk of 0.56 (95% CI 0.33-0.93) for developing diarrheal disease. Similar numbers were found for most other interventions studied. Interestingly, the motivation for action may not always be improved health, but often is simply improved cleanliness and the wish to adhere to cultural norms given the opportunity and resources. It is clear from numerous studies that an increase in water quantity, thus enabling improved hygiene, is more advantageous than focusing on improved water quality. Municipal efforts should improve distribution to slums, which may in turn lead to less household storage, often the primary site of contamination. Efforts to improve

quality can then be targeted to point of use showing a RR of 0.61 (95% CI 0.46–0.81) for developing diarrhea in the Lancet meta-analysis.

Helminths

Another important effect of poor sanitation in slum environments is an impact on the prevalence of geohelminth infections. These include *Ascaris lumbricoides*, *Trichuris trichiura*, and the hookworms *Ancylostoma duodenale* and *Necator americanus* and are thought to cause significant burden of disease, especially among children, including anemia and decreased physical and mental development.²³ It's unclear whether urbanization overall leads to an absolute increase or decrease in these infections, however, it is clearer that the conditions of poor sanitation, lack of water supply, and poverty in urban slums are risk factors for increased infection. The goal of understanding the epidemiologic patterns and risk factors associated with helminth infections in urban settings is to improve targeted sanitation measures as well as mass treatment campaigns and therefore decrease the burden of disease.²³

Globally, the burden of geohelminth infections does not seem to have changed much in the past 50 years, despite the urbanization trends described above. In 1947 Dr. Norman Stoll estimated the global burden of intestinal nematodes in his article "This Wormy World." At that time he estimated a 30% global prevalence with *Ascaris*, 16% with *Trichuris*, and 21% with hookworm. Fifty years later, M Chan, conducting a similar global survey concludes that there has in fact been no decrease in these percentages globally, despite our significant urbanization.²⁴ This continued high prevalence is likely due to the true nature of this urbanization (as described above) rather than effective development. There unfortunately have not been an abundance of studies making direct comparisons in the rates of geohelminthic infections between urban and rural settings. Phiri et al. report a few papers from the 1970s and 80s, but they note that "most studies which mention this issue, however, were not primarily designed to test urban-rural differences, and the groups are often not comparable." In one, the authors found 10% prevalence with intestinal parasites among rural Xhosa children in South Africa, but up to 97% among urban children.²⁵ These authors attribute this stark difference to water-borne sewage exposure in the urban environment. At the same time however, another study, which examined 1742 children from urban and rural environments found 87% helminth infection rate among rural children, with hookworm predominating. Urban children were noted to have a slightly higher rate of protozoan infections, but not helminth infections.²⁶ A study in 1993 conducted on Pembe Island, Zanzibar compared helminth infection rates among school children in one urban and one rural setting. Results indicated high prevalence (>97%) of at least one infection, but no significant difference between study sites.²⁷ A national follow up study 5 years later seems to indicate however a higher prevalence of hookworm in rural children compared to urban children.²⁸ Finally, another small study was conducted in 1998 in Penang Island, Malaysia which showed no significant difference between infection prevalence among rural and urban school children.

Some further insight to this mixed picture has been added in recent years through a few larger and more rigorous studies. A 2000 paper by Phiri et al. explored the urban and rural differences in prevalence and risk factors for intestinal helminth infections in southern Malawi. Stool samples from 553 children (approximately half urban and half rural) were examined for helminth ova and showed a statistically

significant difference of 16.5% versus 3.6% infection among urban versus rural children respectively. The authors note that the majority of this increase is due to *Ascaris*. (These rates are both relatively low as compared to other African contexts, which they comment is consistent with their study region in Malawi) They also used surveys of demographic and socioeconomic information to examine risk factors for infection in the urban setting. Significant risk factors included 'living in an urban area (OR of 5.3, 95% CI 2.6-12.1), having pools of water/sewage around houses, not wearing shoes, not attending school, having mothers with 4-8 years of education, and having mothers below 35 years of age.' They conclude by calling for focusing geohelminth interventions in urban areas.²⁹ Oninla et al. published a cross-sectional study of approximately 750 urban and rural school children in south-western Nigeria.²³ The results of stool examination indicated that 36% of rural and 24% of urban children were infected with at least one intestinal helminth. All three types of helminths examined (*Ascaris*, hookworms, and *Trichuris*) were present in more rural children, however only *Ascaris* was statistically significant. A major weakness of this study however, is that none of the urban children lived in slums, and therefore likely benefit from the improved sanitation which accompanies their higher socioeconomic class. Finally, an interesting review was conducted in 1993 by Crompton and Savioli, in which they predicted a global increase in intestinal parasitic infections, including geohelminths, due to the rapid increases in urbanization. They examine factors in urban poor environments which contribute to easy transmission, highlighting poor sanitation as a major driving factor.¹¹ Interestingly, without adequate water supply, in terms of quantity, other gains in sanitation do not bring down infection rates. Given the mixed results in the literature it's reasonable to conclude that geohelminth infection rates are dependent in part on the local context, with poor sanitation and water supply driving increases in infection rates where present.

Insect-borne diseases

In addition to water borne infectious diseases and geohelminths, there are a number of insect borne diseases which can proliferate in urban slum settings due to open standing water. If populations don't have access to continuous water supplies it will be stored where available in open cisterns. This water may or may not be used for drinking, but will certainly become a breeding ground for various mosquito vectors. Increased malaria rates will be the most obvious result in tropical regions, a warning sounded by Sattler et al.: "In the slums and other underdeveloped settlements, however, poor water supplies (leading to the use of small containers for water storage), poor drainage and small-scale agriculture can create suitable breeding sites for the *Anopheles* vectors and so increase the risk of malaria."³⁰ The most effective intervention to these epidemics of urban malaria are vector control such as insecticide treated bednets and a decrease in standing water. Ensuring continuous adequate and continuous water supply near people's homes will discourage water collection and decrease these breeding grounds.³¹

In addition to malaria, there are a number of other mosquito borne diseases which have become prevalent in urban slum settings, also mostly due an abundance of breeding sites as well as urban crowding. In India in particular Dengue fever has made a resurgence in urban centers, where breeding of the *Aedes aegypti* vector is facilitated by poor water supply and waste disposal.¹⁰ Likewise, lymphatic filariasis has become an urban disease; among the 1200 million people considered at risk, an estimated 350 million (29%) live in urban settings where poor sanitation is the chief risk factor.³² Finally, India and south Asia has experienced regional outbreaks of a new virus in recent years, due in part to poor

sanitation and breeding sites in slums. This virus, the Chikungunya virus, spread again by the *Aedes aegypti* mosquito, is thought to have reemerged and spread more rapidly in urban environments with the advent of irregular tap water in cities.³³

Toward Global and Local Responses

There have been many successful projects and initiatives put in place to improve the lives of slum dwellers and to address the diseases caused by poor sanitation and hygiene and lack of access to safe water. These responses must be multi-factorial and must be driven locally as well as globally. As illustrated above, interventions must be targeted at water supply and waste disposal as well as hygiene practices through education and training. The investments which are required are typically the responsibility of municipal governments, so advocacy for effective policy and the resource commitments to follow through must also be put in place. And in order for these things to be effective and sustainable, they must be done with *participation* between non-governmental organizations, government and local communities. In a paper presented by Anzorena et al. the authors review seven case studies of projects to address urban poverty.³⁴ First, it is telling that one of the primary goals of these projects was to address the health burden through improved infrastructure and sanitation services. Importantly, the authors write: “But the most important reason why the initiatives considered here have given priority to improving housing and basic services is because the poor groups themselves had identified these as their priorities.” Through participatory methods, each of these seven projects was able to empower communities to action and make a meaningful impact on the most important self-identified issues affecting the lives of slum dwellers.

One such global effort, which is drawing more attention to these specific issues are the Millennium Development Goals (MDGs), established by the UN General Assembly in September 2000. The 7th goal in particular deals with ensuring environmental sustainability, and 2 of its targets address water/sanitation and urban slum issues.³⁵ Target 10 calls for a “halving by 2015 of the proportion of people without sustainable access to safe drinking water and sanitation” with indicators of 1) Proportion of urban and rural population with sustainable access to an improved water source and 2) proportion of urban and rural population with access to improved sanitation.¹⁶ Target 11 then states: “Have achieved, by 2020, a significant improvement in the lives of at least 100 million slum dwellers” with the indicator being the proportion of population with access to secure land tenure. The United Nations Family Planning Agency estimates that in order to meet target 10 by 2015, an additional 1.6 billion people will need access to safe drinking water and an additional 2.2 billion people will need access to improved sanitation.¹⁶ Although these are ambitious goals they have started to shift resources toward specific projects and interventions and hold governments accountable to commitments made when signing on to the MDGs.

A local manifestation of this increased attention is the Slum Sanitation Program (SSP) run by the Municipal Corporation of Greater Mumbai.³⁶ This project was created from a 10% allocation of 1995 World Bank funding to the Bombay Sewage Disposal Project of approximately 300 million USD. The SSP was intended to reach poorer neighborhoods and to respond to the inadequate and dilapidated toilet system already in place. This system included approximately 9700 public toilet blocks (or about 77,550

seats). Estimates are that less than 20% were functional, and that even if all worked, they would meet less than 50% of the demand. The SSP emphasizes community participation and delivery of a complete “sanitation package” which includes creation of community based organizations to manage new toilet blocks, hygiene education, construction of the toilet blocks, and other utilities, including water and electricity at the toilet blocks to improve functionality and hygiene practices. Through the community based organizations (CBOs) in particular, community members are engaged in improving their own neighborhoods and trained in proper hygiene practices which they then share with their peers. The project also partners with NGOs to conduct the training of CBOs and construct facilities, such as a project implemented by the World Toilet Organization (WTO) in 2007. The WTO is an NGO working to improve sanitation services around the world.³⁷ To date, the SSP has been relatively successful, although has been slow in scaling up. As of 2003, they had developed over 87 successful sanitation schemes according to this model.

The world is a rapidly urbanizing place, and unfortunately, many of the people in these new cities are not able to take advantage of modern sanitation, hygiene and water supply. This is due to a number of reasons and can lead to increased risk of numerous diseases as outlined in this paper. The goal however, should be to find ways to improve the lives of these urban poor. This will inevitably involve large investments by national and local governments, but must also involve very local community based interventions such as illustrated by the Mumbai Slum Sanitation Program. Whether global efforts at urban development will in fact pay off and lead to improved sanitation for millions of people as happened in the developed world over the last century remains unclear. All we can do is continue to invest and work toward these goals.

References

1. World Urbanization Prospects: The 2007 Revision Population Database. Available at: <http://esa.un.org/unup/> [Accessed November 7, 2008].
2. Sclar ED, Garau P, Carolini G. The 21st century health challenge of slums and cities. *Lancet*. 2005;365(9462):901-3.
3. Galea S, Vlahov D. Urban health: evidence, challenges, and directions. *Annu Rev Public Health*. 2005;26:341-65.
4. Vlahov D, Freudenberg N, Proietti F, et al. Urban as a determinant of health. *J Urban Health*. 2007;84(3 Suppl):i16-26.

5. Waldman A. All Roads Lead to Cities, Transforming India. *The New York Times*. 2005. Available at: <http://www.nytimes.com/2005/12/07/international/asia/07highway.html> [Accessed December 8, 2008].
6. Experts Urge Rethinking of India's Urban Strategy. Available at: <http://www.indiaprwire.com/pressrelease/other/2008061110245.htm> [Accessed December 8, 2008].
7. Singh D. Slum Population In Mumbai : Part I. 2006. Available at: <http://www.iipsenvis.nic.in/vol3no1/slum.pdf> [Accessed December 8, 2008].
8. Dharavi - National Geographic Magazine. Available at: <http://thenationalgeographic.com/2007/05/dharavi-mumbai-slum/jacobson-text> [Accessed December 5, 2008].
9. Volunteer Ramblings: Situation in Mumbai Slums & State Policy. Available at: <http://volunteerthoughts.blogspot.com/2005/08/situation-in-mumbai-slums-state-policy.html> [Accessed December 5, 2008].
10. Utzinger J, Keiser J. Urbanization and tropical health--then and now. *Ann Trop Med Parasitol*. 2006. 100(5-6):517-33.
11. Crompton DW, Savioli L. Intestinal parasitic infections and urbanization. *Bull World Health Organ*. 1993;71(1):1-7.
12. Boadi KO, Kuitunen M. Environmental and health impacts of household solid waste handling and disposal practices in third world cities: the case of the Accra Metropolitan Area, Ghana. *J Environ Health*. 2005;68(4):32-6.
13. Boadi KO, Kuitunen M. Environment, wealth, inequality and the burden of disease in the Accra metropolitan area, Ghana. *Int J Environ Health Res*. 2005;15(3):193-206.
14. Lewin S, Stephens C, Cairncross S. Reviewing the health impacts of improvements in water supply. *Urban Health Newsl*. 1997;(32):34-47.

15. Esrey SA, Potash JB, Roberts L, Shiff C. Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bull World Health Organ.* 1991;69(5):609-21.
16. Bremner J, Bilsborrow R. Population Dynamics and Millennium Development Goal 7. 2005. Available at: <http://www.populationenvironmentresearch.org/papers/Pop&MDG7.pdf> [Accessed December 6, 2008].
17. Fewtrell L, Kaufmann RB, Kay D, et al. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *Lancet Infect Dis.* 2005;5(1):42-52.
18. WHO | The world health report 2002 - Reducing Risks, Promoting Healthy Life. Available at: <http://www.who.int/whr/2002/en/> [Accessed December 9, 2008].
19. Varanasi - Wikipedia, the free encyclopedia. Available at: <http://en.wikipedia.org/wiki/Varanasi> [Accessed November 7, 2008].
20. Hamner S, Tripathi A, Mishra RK, et al. The role of water use patterns and sewage pollution in incidence of water-borne/enteric diseases along the Ganges river in Varanasi, India. *Int J Environ Health Res.* 2006;16(2):113-32.
21. Graf J, Meierhofer R, Wegelin M, Mosler H. Water disinfection and hygiene behaviour in an urban slum in Kenya: impact on childhood diarrhoea and influence of beliefs. *Int J Environ Health Res.* 2008;18(5):335-55.
22. Gladstone BP, Muliylil JP, Jaffar S, et al. Infant morbidity in an Indian slum birth cohort. *Arch Dis Child.* 2008;93(6):479-84.
23. Oninla SO, Owa JA, Onayade AA, Taiwo O. Intestinal helminthiasis among rural and urban schoolchildren in south-western Nigeria. *Ann Trop Med Parasitol.* 2007;101(8):705-13.
24. Chan MS. The global burden of intestinal nematode infections--fifty years on. *Parasitol Today.* 1997;13(11):438-43.

25. van Niekerk CH, Weinberg EG, Shore SC, de Heese H. Intestinal parasitic infestation in urban and rural Xhosa children. A comparative study. *S Afr Med J*. 1979;55(19):756-7.
26. Onubogu UV. Intestinal parasites of school children in urban and rural areas of Eastern Nigeria. *Zentralbl Bakteriol [Orig A]*. 1978;242(1):121-32.
27. Albonico M, De Carneri I, Di Matteo L, et al. Intestinal parasitic infections of urban and rural children on Pemba Island: implications for control. *Ann Trop Med Parasitol*. 1993;87(6):579-83.
28. Albonico M, Chwaya HM, Montresor A, et al. Parasitic infections in Pemba Island school children. *East Afr Med J*. 1997;74(5):294-8.
29. Phiri K, Whitty CJ, Graham SM, Ssembatya-Lule G. Urban/rural differences in prevalence and risk factors for intestinal helminth infection in southern Malawi. *Ann Trop Med Parasitol*. 2000;94(4):381-7.
30. Sattler MA, Mtasiwa D, Kiama M, et al. Habitat characterization and spatial distribution of *Anopheles* sp. mosquito larvae in Dar es Salaam (Tanzania) during an extended dry period. *Malar J*. 2005;4:4.
31. Knudsen AB, Slooff R. Vector-borne disease problems in rapid urbanization: new approaches to vector control. *Bull World Health Organ*. 1992;70(1):1-6.
32. Erlanger TE, Keiser J, Caldas De Castro M, et al. Effect of water resource development and management on lymphatic filariasis, and estimates of populations at risk. *Am J Trop Med Hyg*. 2005;73(3):523-33.
33. Das S, Kolher RP, Mane BG, Singh JPN, Singh AP. Chikungunya epidemic: global and Indian scenario. *J Commun Dis*. 2007;39(1):37-43.
34. Anzorena J. Reducing urban poverty; some lessons from experience. Available at: http://www.ucl.ac.uk/dpu-projects/21st_Century/resources/papers/documents/anzorena.PDF [Accessed December 6, 2008].

35. Goal 7: Ensure environmental sustainability. Available at: <http://www.undp.org/mdg/goal7.shtml> [Accessed December 6, 2008].

36. Reaching the poor through sustainable partnerships : the Slum Sanitation Program in Mumbai, India, Vol. 1 of 1. Available at: http://www-wds.worldbank.org/servlet/main?menuPK=64187510&pagePK=64193027&piPK=64187937&theSitePK=523679&entityID=000333038_20080604040322 [Accessed December 10, 2008].

37. The Tipping Point- Slum Sanitation Mumbai | Changemakers. Available at: <http://www.changemakers.net/node/6058> [Accessed December 5, 2008].